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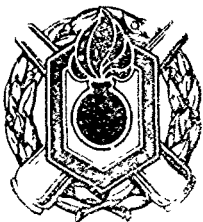
Technical Report ARAED-TR-92010

**QUALIFICATION TEST OF HANDLE STRAP, P/N 9381751
MANUFACTURED BY PANDUIT CORPORATION FOR
81-mm MORTAR AMMUNITION FIBER CONTAINER**

Yuen H. Lam
Edward S. Guida



May 1992



US ARMY
ARMAMENT MUNITIONS
& CHEMICAL COMMAND
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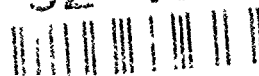
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| 12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited. | | | 12b. DISTRIBUTION CODE | |
| 13. ABSTRACT (Maximum 200 words) This report details the tests conducted on the plastic handle straps, drawing 9381751, needed to assemble the plastic handles to fiber (tube) containers used to pack the 81-mm mortar ammunition. The strength of straps received from Thomas & Betts Corporation, the approved source of supply stated on the drawing, was compared with those by Panduit Corporation, a candidate supplier. Test runs stressed the strap's material and locking device to failure after 2 hr of temperature conditioning at -50 degrees F, +70 degrees F, and +160 degrees F. The test results indicated that the strength of Panduit candidate strap samples was much less than that of the Thomas & Betts' product, therefore, not acceptable for use to pack the 81-mm mortar ammunition in their fiber containers. | | | | |
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CONTENTS

| | Page |
|-------------------|------|
| Introduction | 1 |
| Discussion | 2 |
| Test Limitations | 2 |
| Test Results | 3 |
| Conclusions | 6 |
| Recommendations | 7 |
| Distribution List | 25 |

FIGURES

| | | |
|----|--|----|
| 1 | Plastic handle strap for 81 mm mortar ammunition fiber container | 9 |
| 2 | Drawing for strap handle for 81 mm mortar ammunition fiber container | 10 |
| 3 | Tinius Olsen (model 1000) testing machine | 11 |
| 4 | Strap material strength test | 12 |
| 5 | Strap's locking device strength test | 13 |
| 6 | Handle strap test results | 14 |
| 7 | 81 mm M879 plastic handle straps, material strength test (temperature conditioned for 2 hr) | 15 |
| 8 | 81 mm M879 plastic handle straps, locking device strength test (temperature conditioned for 2 hr) | 16 |
| 9 | 81 mm M879 plastic handle straps, material strength test (conditioned 2 hr at ambient) | 17 |
| 10 | 81 mm M879 plastic handle straps, locking device strength test 18 (conditioned 2 hr at ambient) | |

FIGURES (cont)

| | Page |
|---|------|
| 11 81 mm M879 plastic handle straps, material strength test (conditioned 2 hr at +160°F) | 19 |
| 12 81 mm M879 plastic handle straps, locking device strength test (conditioned 2 hr at +160°F) | 20 |
| 13 81 mm M879 plastic handle straps, material strength test (conditioned 2 hr at -50°F) | 21 |
| 14 81 mm M879 plastic handle straps, locking device strength test (conditioned 2 hr at -50°F) | 22 |
| 15 Locking devices of Thomas & Betts and Panduit Corporation | 23 |

INTRODUCTION

The 81 mm fiber ammunition container (PA114) has a plastic handle that is assembled to the container with two plastic straps during the loading, assembling, and packing (LAP) of the M879 practice mortar cartridge. These nylon 6/6 (weather resistant) straps (fig. 1) are approximately 14 in. long, 3/16 in. wide, and 3/64 in. thick. There is "locking device" at one end and throughout its length are transverse serrations. When the strap is threaded through its locking device to create a hoop, the transverse serrations act as a one-way ratchet. The strap is able to continue through the locking device to make a smaller hoop but cannot be pulled back out--it locks in place. The approved source of supply is the Thomas and Betts Corporation (T&B) (fig. 2). T&B state that the strength rating of its product is 50 lb, i.e., once locked in place it withstands a minimum of a 50-lb pull force without damage or distortion.

The Milan Army Ammunition Plant (MAAP), Milan, TN produces the 81 mm M879 practice mortar cartridge for the Army. The contractor-operator is Martin Marietta Ordnance Systems (MMOS); as required by the technical data package (TDP), 600 units were manufactured and prepared for shipment to Aberdeen Proving Ground (APG), Aberdeen, MD for a production qualification test in October 1991. Part of the shipping requirement was to x-ray all units prior to shipment. When the technician opened the wood box overpack to remove the PA114 with its M879 mortar round, some of the plastic straps broke. Upon completion of the x-ray task, the technician repacked the M879 mortar round into its PA114 fiber container and then placed the repacked containers into the wood box overpack without replacing the broken straps, or notifying anyone that broken straps existed before making the shipment to APG. During the unpack and repack process another problem became manifest. When the plastic handle was oriented at an angle inside the wood box, it would hook on the box and cause a strap to break when an attempt was made to remove the packed PA114 container with cartridge. Upon becoming aware of this problem, MMOS reinstructed all contract employees to follow current procedures when packing and unpacking the mortar cartridges during LAP and x-ray operation.

At APG, the noted shipment went through an initial receipt inspection. The inspector selected boxes to obtain 20 cartridges for inspection. The opened boxes revealed six broken handle straps and, as the inspector began to remove packed PA114 containers with cartridges from their wood box confinement, six more straps broke. A missing or broken strap is considered a minor defect per the TDP; however, the number of broken straps that were seen was not acceptable. A product quality deficiency report (QDR) was written² that stated there was a 40% deficiency rate in the

¹TECOM project 2-MU-001-879-006.

²Product quality deficiency report W4QVAA-91-001.

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inspection quantity sent to APG. The QDR was furnished to cognizant persons at the U.S. Army Armament Munitions and Chemical Command (AMCCOM), the U. S. Army Armament Research Development and Engineering Center (ARDEC), and MMOS. MMOS explained the unacceptable strap as an error in drawing interpretation; they did not consider T&B as the only approved source for straps; therefore, they purchased the straps from Panduit Corporation (PC) without seeking approval from the government as stipulated on the strap drawings. They stated that the note on the drawing that required government approval to use any other supplier did not exist at the time the straps were purchased. In contemplation of seeking approval to use the PC straps, MMOS furnished ARDEC with sample units for testing. Furthermore, packing procedures were amended to require that each loaded fiber ammunition container be lifted by its plastic handle to ascertain that neither the straps nor the handle were damaged. In light of the stated introduction and background, a test and evaluation (T&E) was put in process at ARDEC to determine whether the PC straps were acceptable as being equivalent to the T&B product. This report discusses that T&E program.

DISCUSSION

The test program that was established to compare the handle straps supplied by PC with those supplied by T&B was limited to comparing their relative strengths when they were given axial pulls at ambient, high and low temperature conditioning. Two basic pull tests were run to create the necessary data from which the engineering conclusion was based. One test was an axial pull on a strap that was extended straight to determine whether the strap's basic strength was satisfactory; the other was a pull on a strap that was formed into a hoop to determine if the strap's locking device design was contributing to strap failures.

To place the test series in process, damaged straps from Aberdeen were brought to ARDEC and subjected to the noted pull tests. Concurrently, new straps were obtained from the two noted suppliers and subjected to the same test series. All data obtained was evaluated and used as the basis for determining equivalency.

Test Limitations

To have the straps undergo the same stress conditions, the following overall test limitations were established and maintained:

1. Temperature conditioning was done for a 2-hr minimum at the selected temperature ranges listed below:

- Ambient: $+70^{\circ}\text{F} \pm 2^{\circ}\text{F}$
- High: $+160^{\circ}\text{F} \pm 2^{\circ}\text{F}$
- Low: $-50^{\circ}\text{F} \pm 2^{\circ}\text{F}$

2. Pull tests were done within 1 min. of removing the test specimen from the temperature conditioning chamber.

3. Pull tests were done on the Tinius Olsen (model 1000) testing machine (fig. 3) located in the Materials Testing Laboratory at ARDEC, on the 7th, 8th, and 13th of January 1992.

4. Pull speed was set at 4/10 in./min.

5. The strap material strength test pulls were performed by applying a straight pull on an extended strap (fig. 4).

6. The strap's locking device strength test pulls were done by applying a force through the 12- and 6-o'clock axis points of the closed circle (hoop) with the locking device located at the 3-o'clock position. Once under stress, the locking device had to demonstrate an ability to withstand a 50-lb force (fig. 5).

7. A matrix of the test results for easy reference is represented in figure 6. The average failure points to two manufactures' products under different test temperatures in two test modes are shown in figures 7 and 8, respectively.

Test Results

In light of the listed general test limitations, the test results and comments made at the time were:

1. Pull tests at ambient temperature.

For this test series element, five test samples were used to obtain force values for each strap characteristic being evaluated, i.e., material and locking device design, 10 total.

- For the material strength tests, one broken strap from APG, one new strap from T&B, and three candidate straps from PC were used. A continuous axial pull was applied until the strap failed. The point of failure for each strap was:

| | |
|-------------|---------|
| APG-1 strap | 77.0 lb |
| T&B-1 strap | 69.2 lb |
| PC-1 strap | 59.5 lb |
| PC-2 strap | 57.2 lb |
| PC-3 strap | 61.3 lb |

- For the locking device design strength tests, two straps from T&B and three candidate straps from PC were used. It should be noted that the failure mode during this test could be either the locking device or the strap material. After forming a hoop, the test pull was applied as noted earlier. The hoop failure point for each pull was:

| | |
|-------------|---|
| T&B-1 strap | Locking device failed (slipped) at 100.7 lb |
| T&B-2 strap | Locking device failed (slipped) at 106.8 lb |
| PC-1 strap | Locking device broke at 65.2 lb |
| PC-2 strap | Locking device broke at 41.1 lb |
| PC-3 strap | Locking device broke at 47.9 lb |

The test results itemized above are graphically shown in figures 9 and 10.

2. Pull tests after 2 hr of temperature preconditioning at $+160^{\circ} \pm 2^{\circ}\text{F}$.

- For the material strength tests, three straps came from T&B and three came from PC. The strap material failure point for each pull was:

| | |
|-------------|----------|
| T&B-1 strap | 101.6 lb |
| T&B-2 strap | 95.9 lb |
| T&B-3 strap | 87.1 lb |
| PC-1 strap | 84.0 |
| PC-2 strap | 83.0 lb |
| PC-3 strap | 84.0 lb |

- For the locking device strength tests, three units came from T&B and six came from PC. The failure point for each locking device was:

| | |
|-------------|--|
| T&B-1 strap | Locking device failed (slipped) at 70 lb |
| T&B-2 strap | Locking device failed (slipped) at 47 lb |
| T&B-3 strap | Locking device failed (slipped) at 60 lb |
| PC-1 strap | Locking device broke at 40 lb |
| PC-2 strap | Locking device broke at 40 lb |
| PC-3 strap | Locking device broke at 40 lb |
| PC-4 strap | Locking device broke at 46 lb |
| PC-5 strap | Locking device broke at 45 lb |
| PC-6 strap | Locking device broke at 34 lb |

The test results delineated above are graphically shown in figures 11 and 12.

3. Pull tests after 2 hr of temperature preconditioning at $-50^{\circ}\text{F} \pm 2^{\circ}\text{F}$.

- For the material strength tests, one strap came from T&B and three came from PC. The strap failure point for each pull was:

| | |
|-------------|---------|
| T&B-1 strap | 94.3 lb |
| PC-1 strap | 63.5 lb |
| PC-2 strap | 62.5 lb |
| PC-3 strap | 64.0 lb |

- For the locking device design strength tests, two samples were supplied by T&B and six candidate samples were furnished by PC. The locking device design failure points for each pull was:

| | |
|-------------|---|
| T&B-1 strap | Locking device failed (slipped) at 122 lb |
| T&B-2 strap | Locking device failed (slipped) at 92 lb |

PC-1 through 5
strap

Note: All the five locking devices of these PC straps broke immediately upon removal from the temperature conditioning chamber at zero load conditions

PC-6 strap

Locking device broke at 90 lb

The test results delineated above are graphically shown in figures 13 and 14.

Note that all locking devices of the T&B straps only slipped while the PC straps broke completely when critical failure points were reached (fig. 15).

CONCLUSIONS

While the test quantity is too small to support a meaningful statistical computation, the data reveal significant results that merit comments.

1. The test was designed to be a simple qualitative comparison of the Panduit Corporation (PC) handle straps with those supplied by the Thomas and Betts Corporation (T&B). As such, the PC straps demonstrated a marked deficiency in strength at the locking device area; therefore, they are not equivalent. The following summary of the tests run at the three preconditioned temperatures contains additional comments in regard to the PC handle straps behavior.

- At ambient temperature conditioning, two of the three PC handle strap locking devices failed to withstand a 50-lb pull force. The force values to failure were 65.2, 41.1, and 47.9 lb, respectively. However, the strap material strength exceeded the 50-lb minimum rating of the T&B straps.

- At high temperature conditioning (+160°F), three PC items were tested for material strength and exceeded the 50-lb minimum rating. For the locking device strength pulls, six PC candidates were stressed to failure. All six did not meet the 50-lb minimum pull requirement. Their failure values were 40, 40, 40, 46, 45, and 34 lb, respectively.

- At the low temperature (-50°F) pull testing, three PC candidates were stressed to failure to ascertain the strap's strength. All three exceeded the 50-lb failure rating. However, the results were dramatically different for the locking device. Six PC candidate straps were conditioned for testing. Five of the six failed in the locking device area at zero load immediately upon removal from the temperature conditioning chamber. The sixth strap's locking device strength exceeded the 50-lb pull rating. The six failure values were 0, 0, 0, 0, 0, and 90 lb.

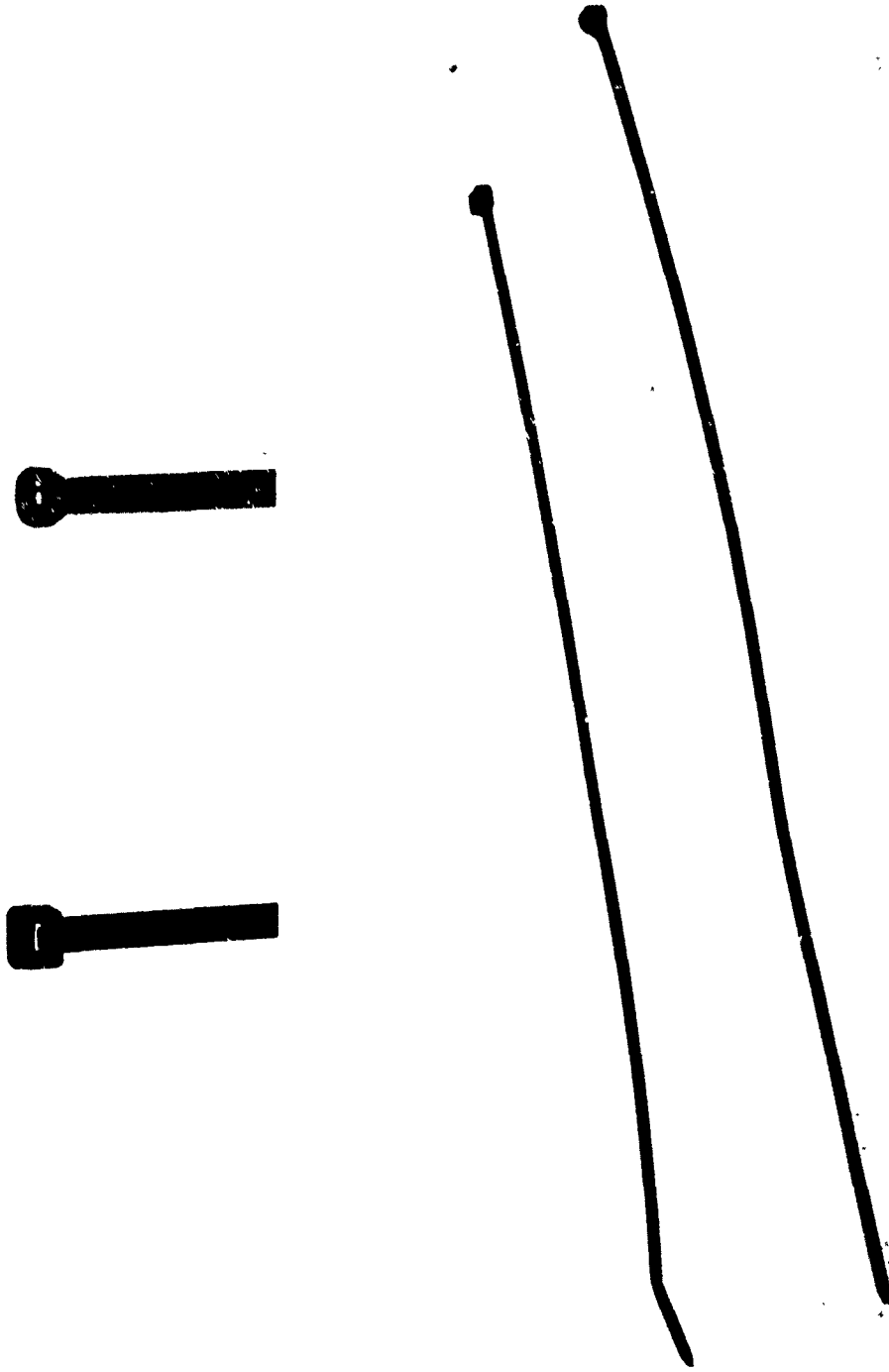
2.. The T&B items exceeded their 50-lb pull rating in the pull tests after temperature conditioning at -50°F and +70°F. During the hoop test after +160°F temperature conditioning, one of three locking devices failed at 47 lb. It must be emphasized that all the locking devices of T&B straps only slipped when the critical failure points were reached, comparing to those of the PC straps which completely broke during the tests.

Based on the test data obtained and recorded, the PC candidate handle straps sent to U.S. Army Research, Development and Engineering Center for test and evaluation were judged not acceptable for use.

RECOMMENDATIONS

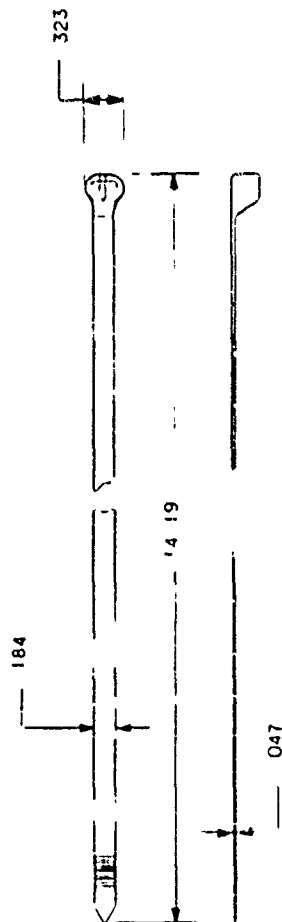
No comments are made in regard to the Panduit Corporation's candidate handle straps that were offered as being equivalent to the Thomas and Betts product. Tests run at U.S. Army Research, Development and Engineering Center found the candidate items not equivalent, therefore, not acceptable.

To be considered as an approved alternate supplier for handle straps, Panduit Corporation must make the strap material and locking device behave in such a manner that the two design characteristics, strap material and locking device strengths, will accommodate or withstand a 50-lb minimum pull force when conditioned to the three standard temperatures, i.e., +70°F, +160°F, and -50°F.



Thomas & Betts Corporation plastic handle strap--top (right)--bottom (front)
Panduit Corporation plastic handle strap--top (left)--bottom (back)

Figure 1. Plastic handle strap for 81 mm mortar ammunition fiber container



NOTES

1. REQUIREMENTS

A. MATERIAL - HIGHLY ORIENTED NYLON-6

2. IDENTIFICATION OF THE SUGGESTED SOURCE OF SUPPLY HEREON

IS NOT TO BE CONSTRUED AS A GUARANTEE OF PRESENT OR CONTINUED AVAILABILITY AS A SOURCE OF SUPPLY FOR THE ITEM.

3. SUGGESTED SOURCE OF SUPPLY

THOMAS AND BETTS CORPORATION

SZO ROUTE 202

RAPIDAN N J 08669

VENDOR PART NO 1Y28MX OR 1Y528MX

FSLM NO

4. ONLY A STRAP, HANDLE PROCURED FROM A VENDOR LISTED ON THIS DRAWING AND IDENTIFIED BY SUCH VENDOR'S IDENTIFYING NUMBER AS ALSO LISTED HEREON HAS BEEN TESTED AND/OR APPROVED BY ARDEC FOR USE. A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR TESTING AND/OR APPROVAL BY ARDEC, PICATINNY ARSENAL, N.J. 07306-5000.

SOURCE CONTROL DRAWING
PART NO. 9381751

Figure 2. Drawing for strap handle for 81 mm mortar ammunition fiber container

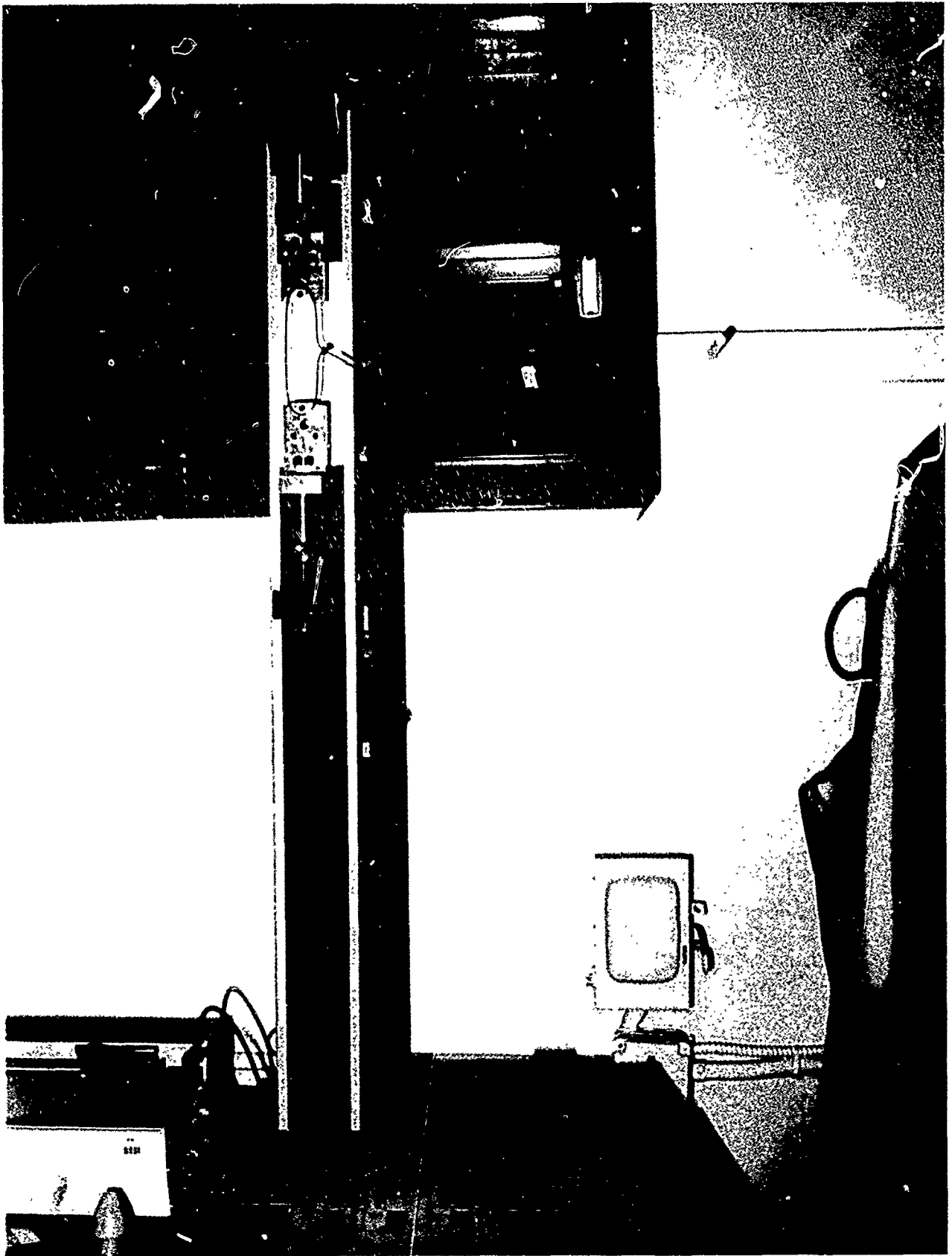


Figure 3. Tinius Olsen (model 1000) testing machine

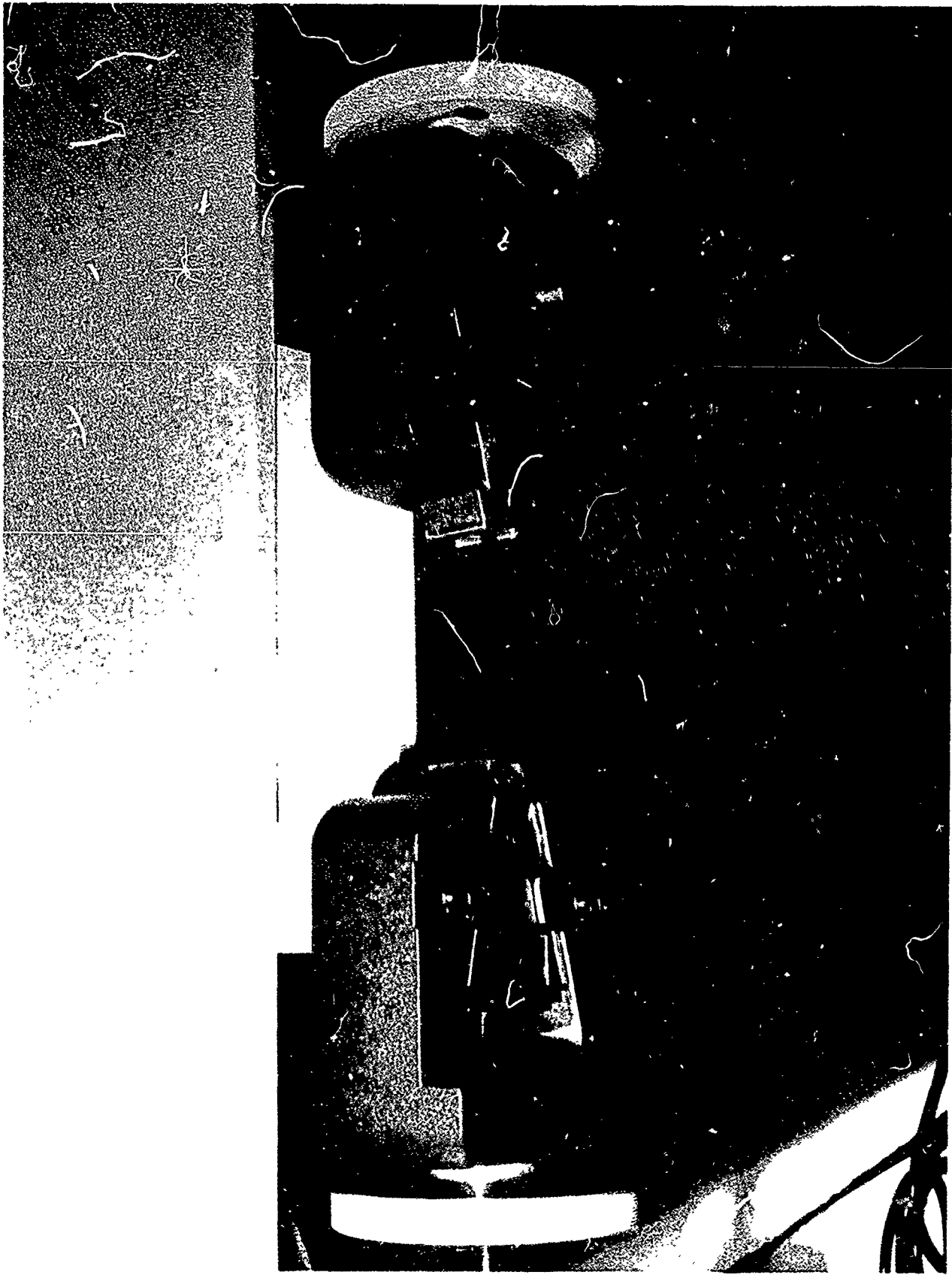


Figure 4. Strap material strength test

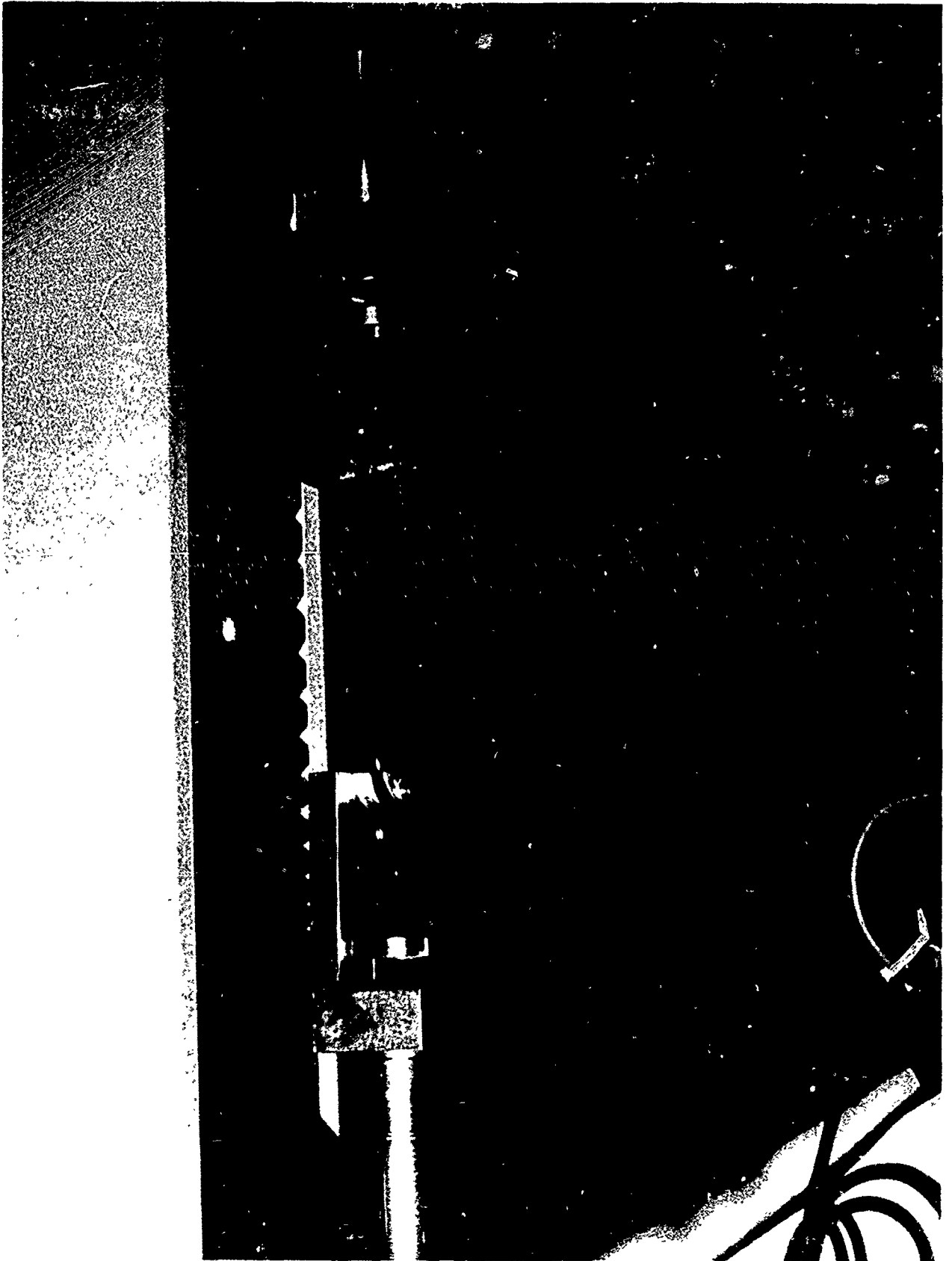


Figure 5. Strap's locking device strength test

| TEMP. | SOURCE | LOT NO. | FAILURE POINTS IN POUNDS | |
|--------|--------|--|--------------------------|----------------|
| | | | STRAPS | LOCKING DEVICE |
| +70°F | PC | APG GYB89J002-002 GYB89H002-001 GYB88G001-002 | 77.9 | 100.7 |
| | T&B | | 69.2 | 105.8 |
| | T&B | | | 65.2 |
| | PC | | 59.5 | 41.1 |
| | PC | | 57.2 | 47.9 |
| +160°F | PC | GYB89J002-002 GYB89H002-001 GYB88G001-002 | 61.3 | |
| | T&B | | 101.6 | 79.0 |
| | T&B | | 95.9 | 47.0 |
| | T&B | | 87.1 | 60.0 |
| | PC | | 84.0 | 40.0 |
| | PC | | | 40.0 |
| | PC | | 83.0 | 40.0 |
| | PC | | | 46.0 |
| | PC | | 84.0 | 45.0 |
| | PC | | | 34.0 |
| -50°F | T&B | GYB89J002-002 GYB89H002-001 GYB88G001-002 | 94.3 | 122.0 |
| | T&B | | 63.5 | 92.0 |
| | PC | | | 0 |
| | PC | | | 0 |
| | PC | | 62.5 | 90.0 |
| | PC | | | 0 |
| | PC | | 64.0 | 0 |

Figure 6. Handle strap test results

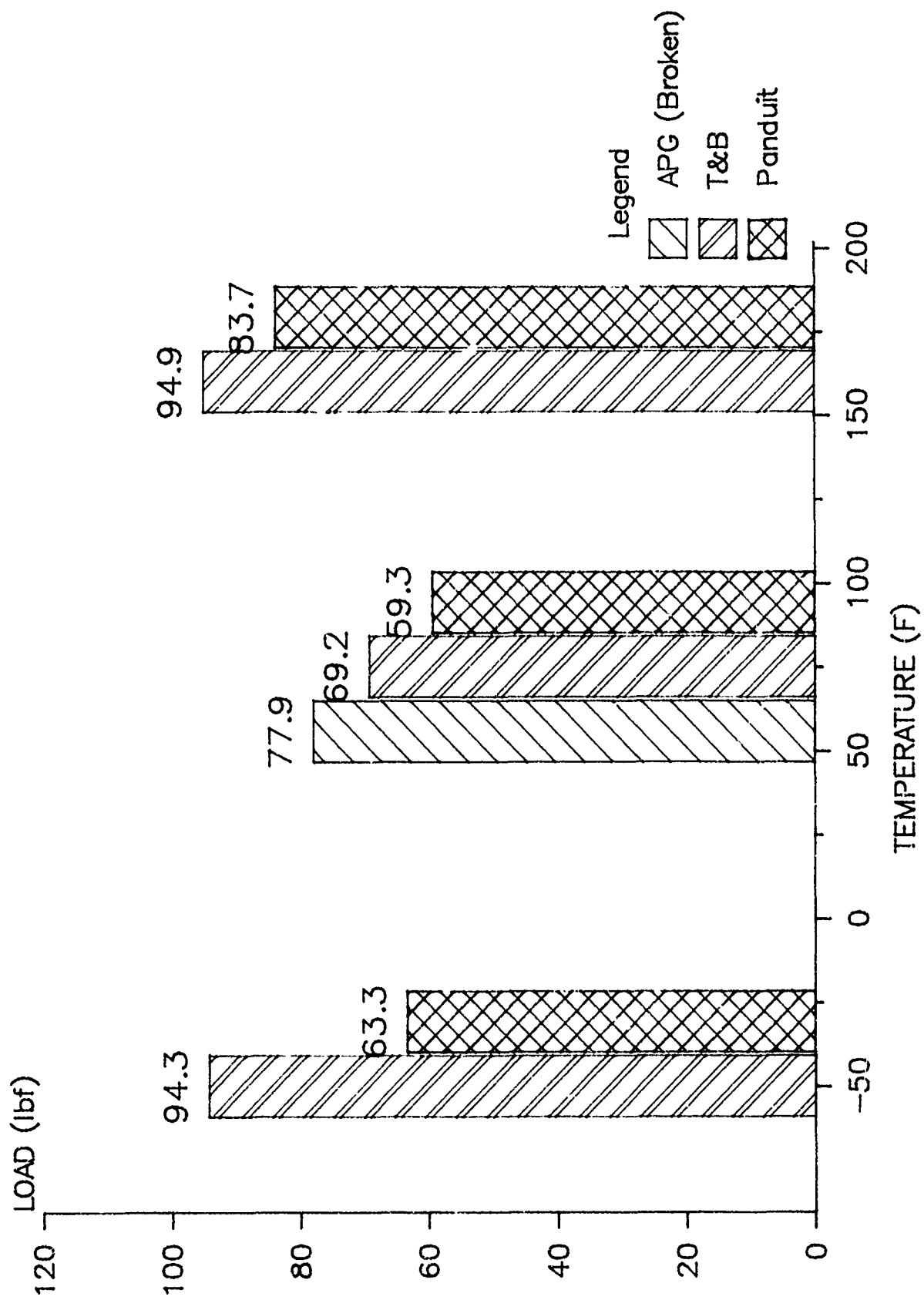


Figure 7. 81 mm M879 plastic handle straps, material strength test (temperature conditioned for 2 hr)

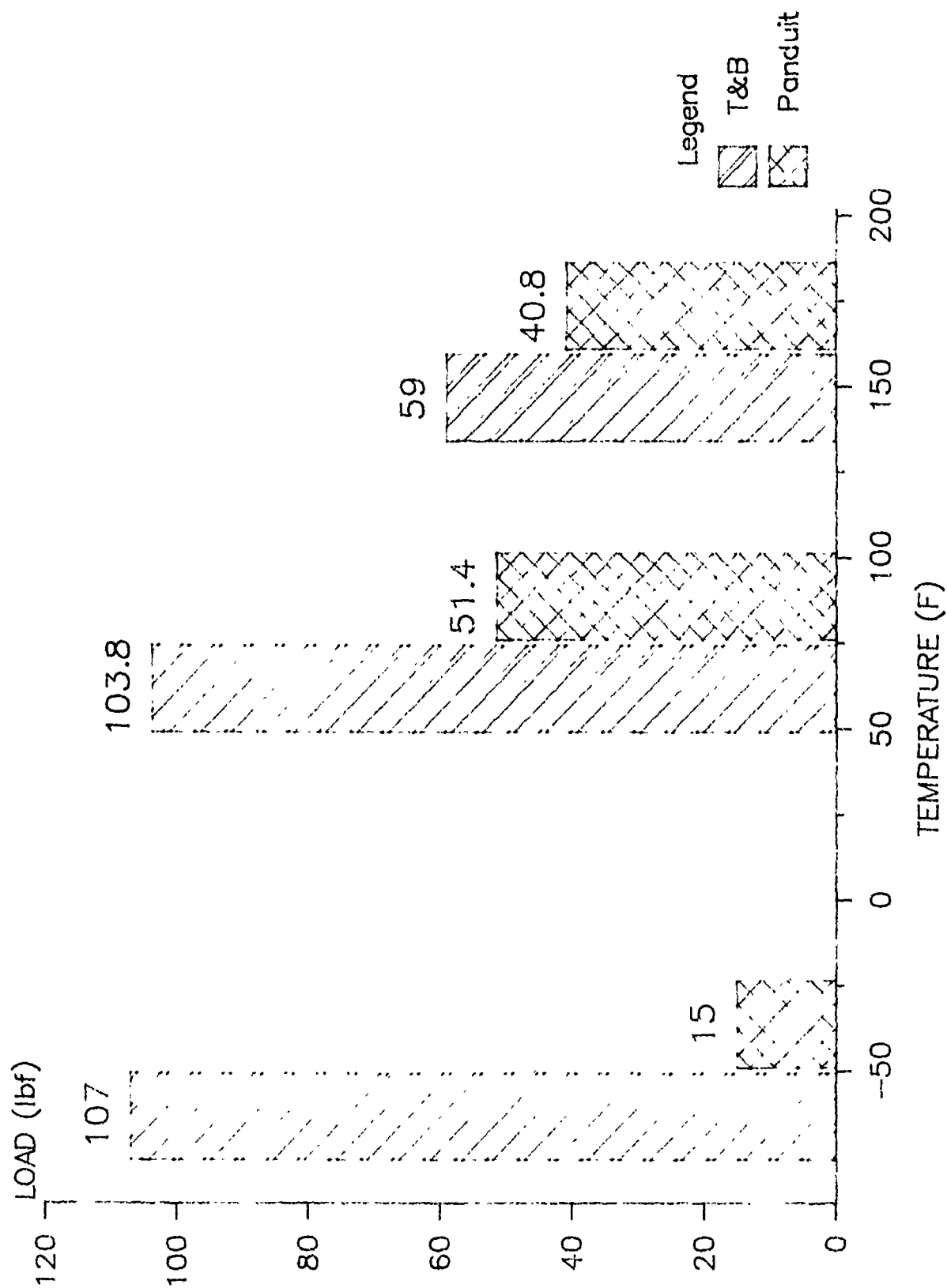


Figure 8. 81 mm M879 plastic handle straps, locking device strength test (temperature conditioned for 2 hr)

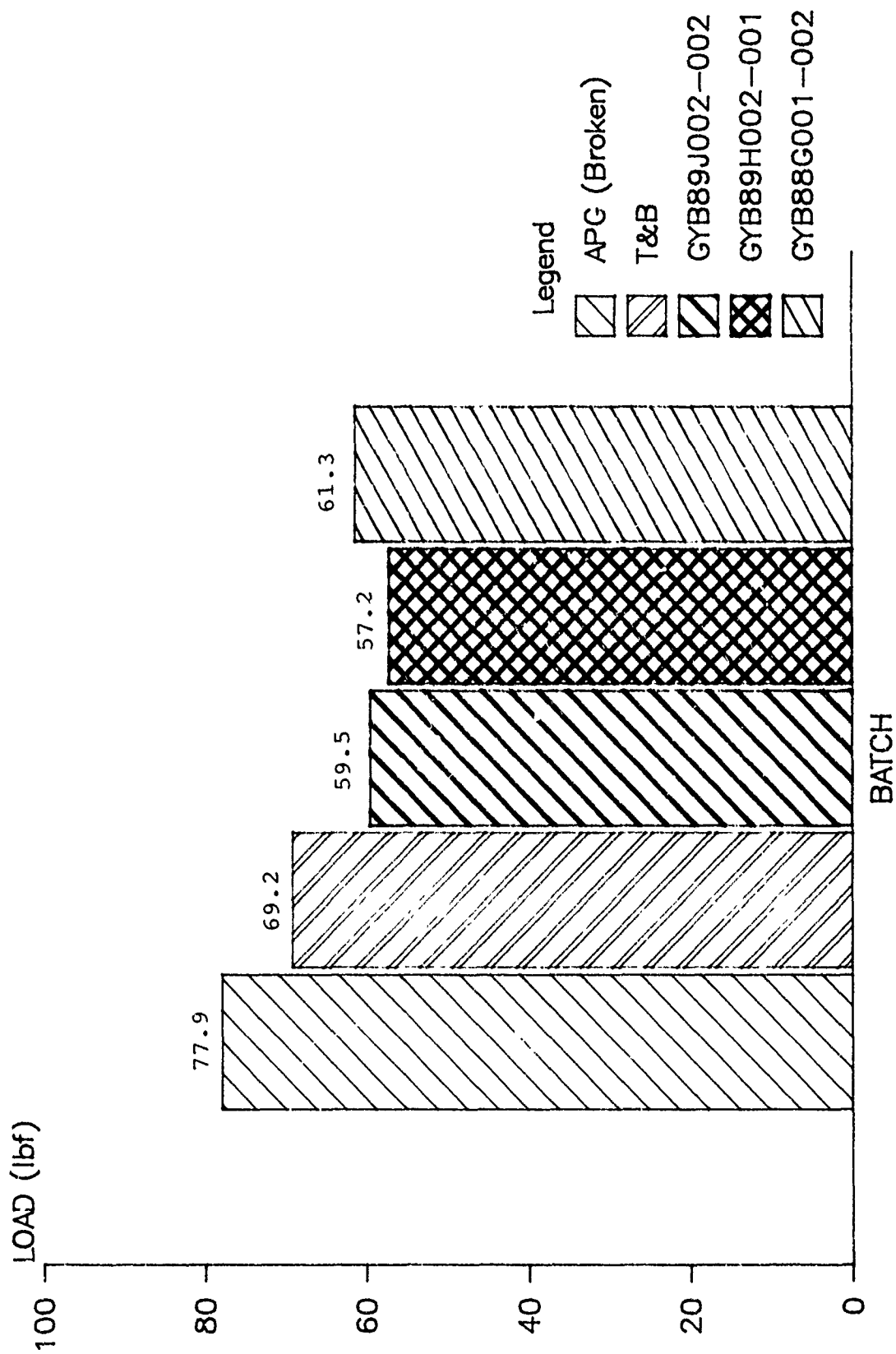


Figure 9. 81 mm M879 plastic handle straps, material strength test (conditioned 2 hr at ambient)

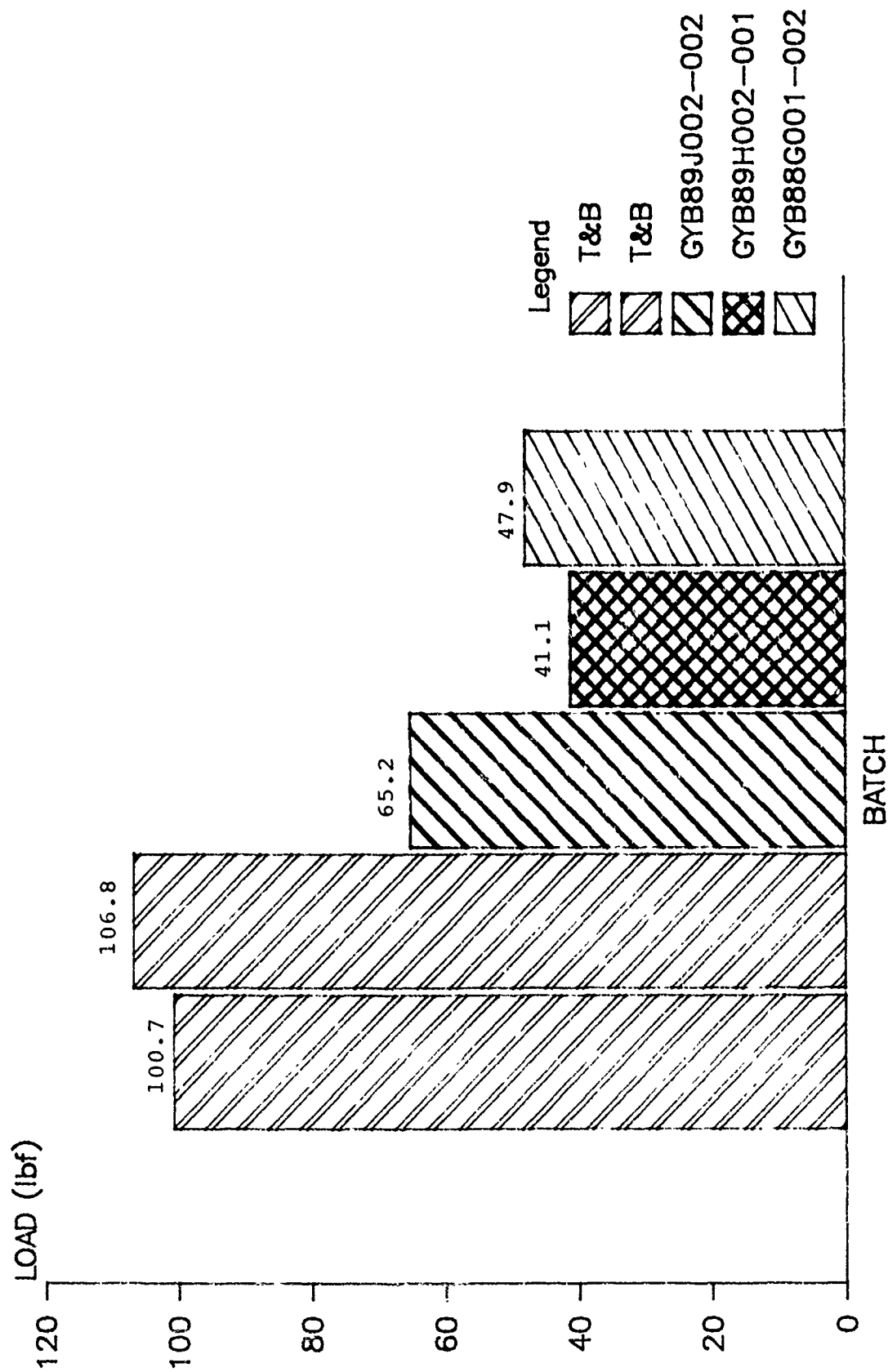


Figure 10. 81 mm M879 plastic handle straps, locking device strength test (conditioned 2 hr at ambient)

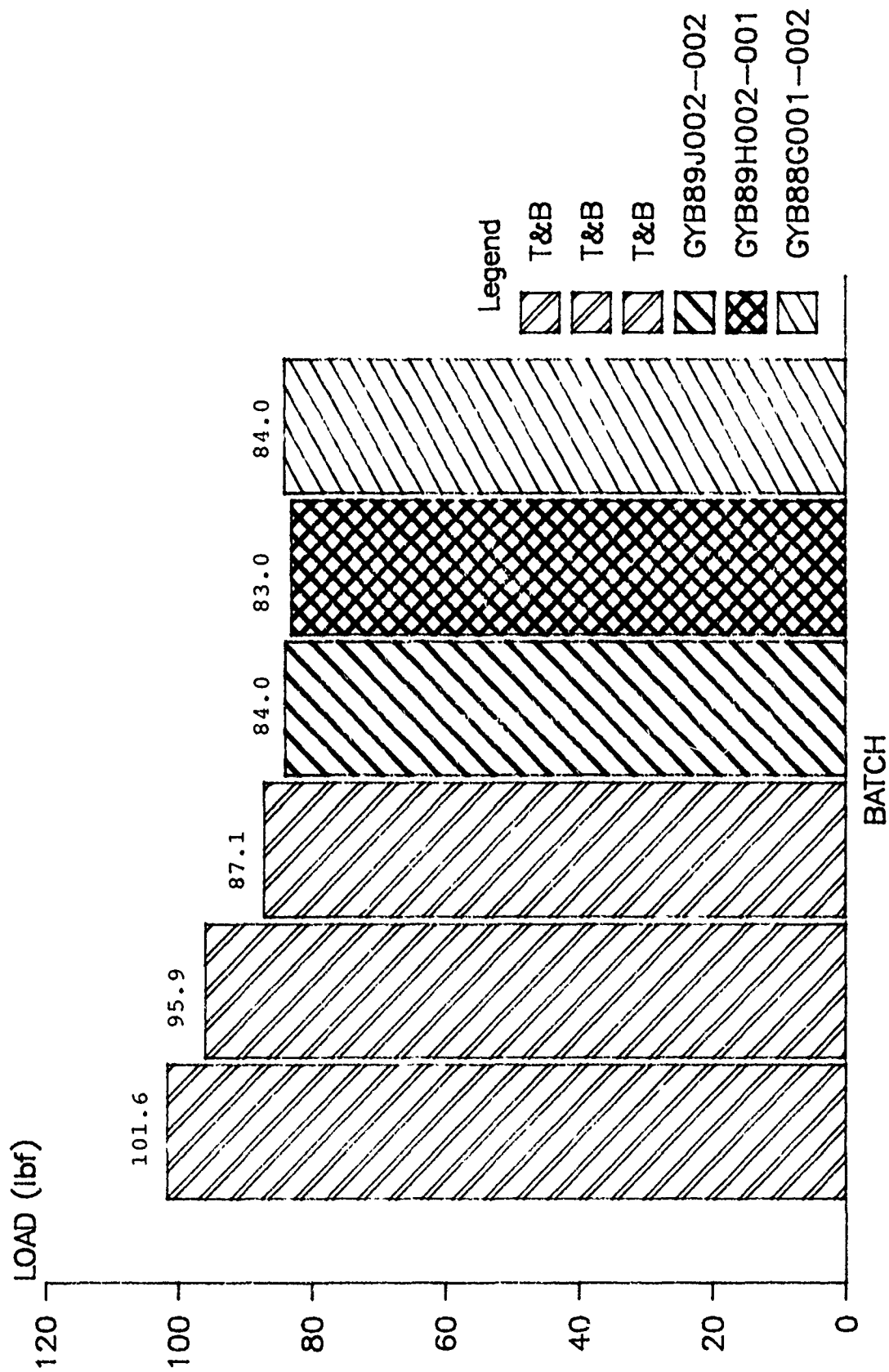


Figure 11. 81 mm M879 plastic handle straps, material strength test (conditioned 2 hr at +160°F)

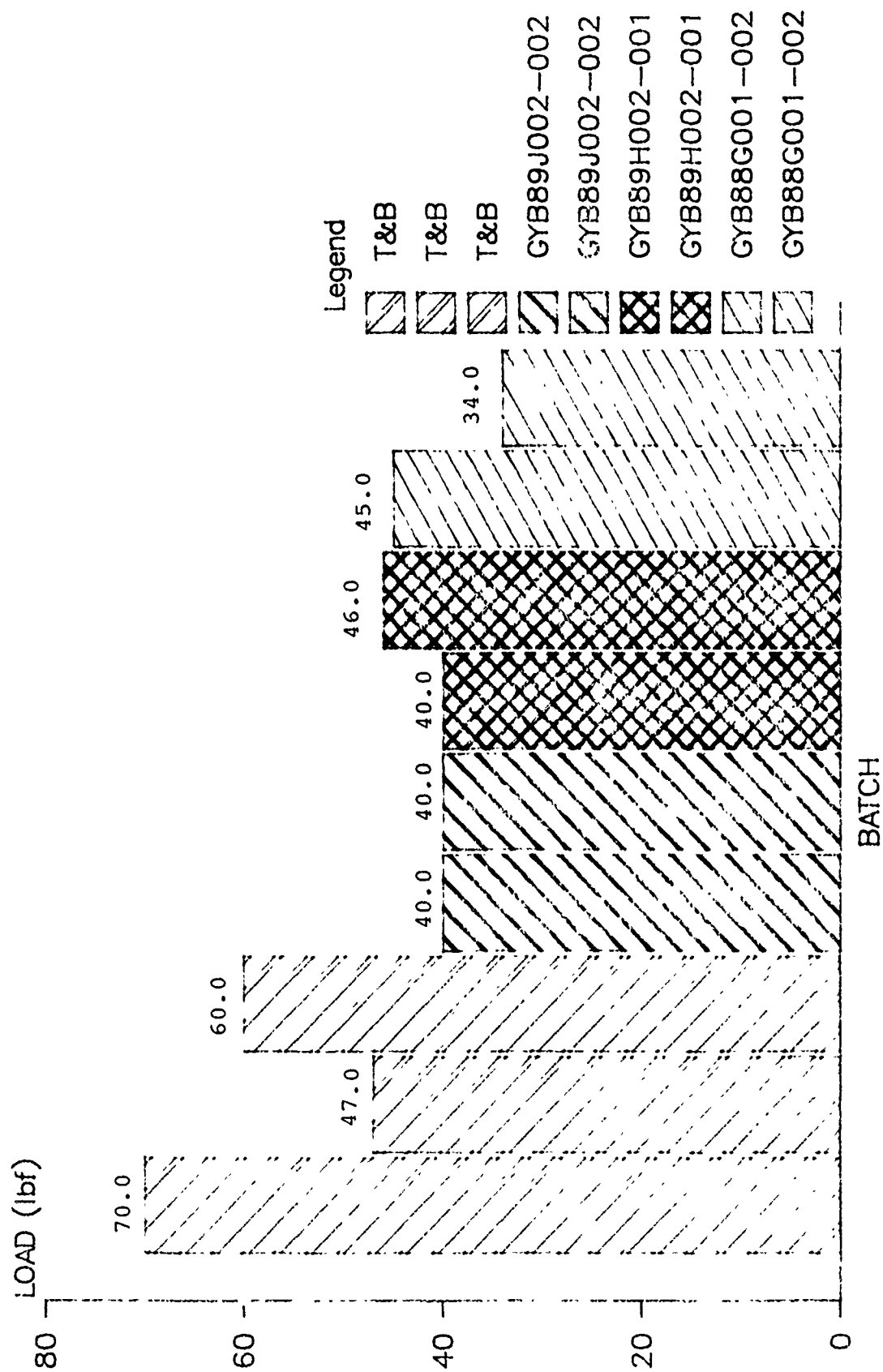


Figure 12. 81 mm M879 plastic handle straps, locking device strength (conditioned 2 hr at +160°F)

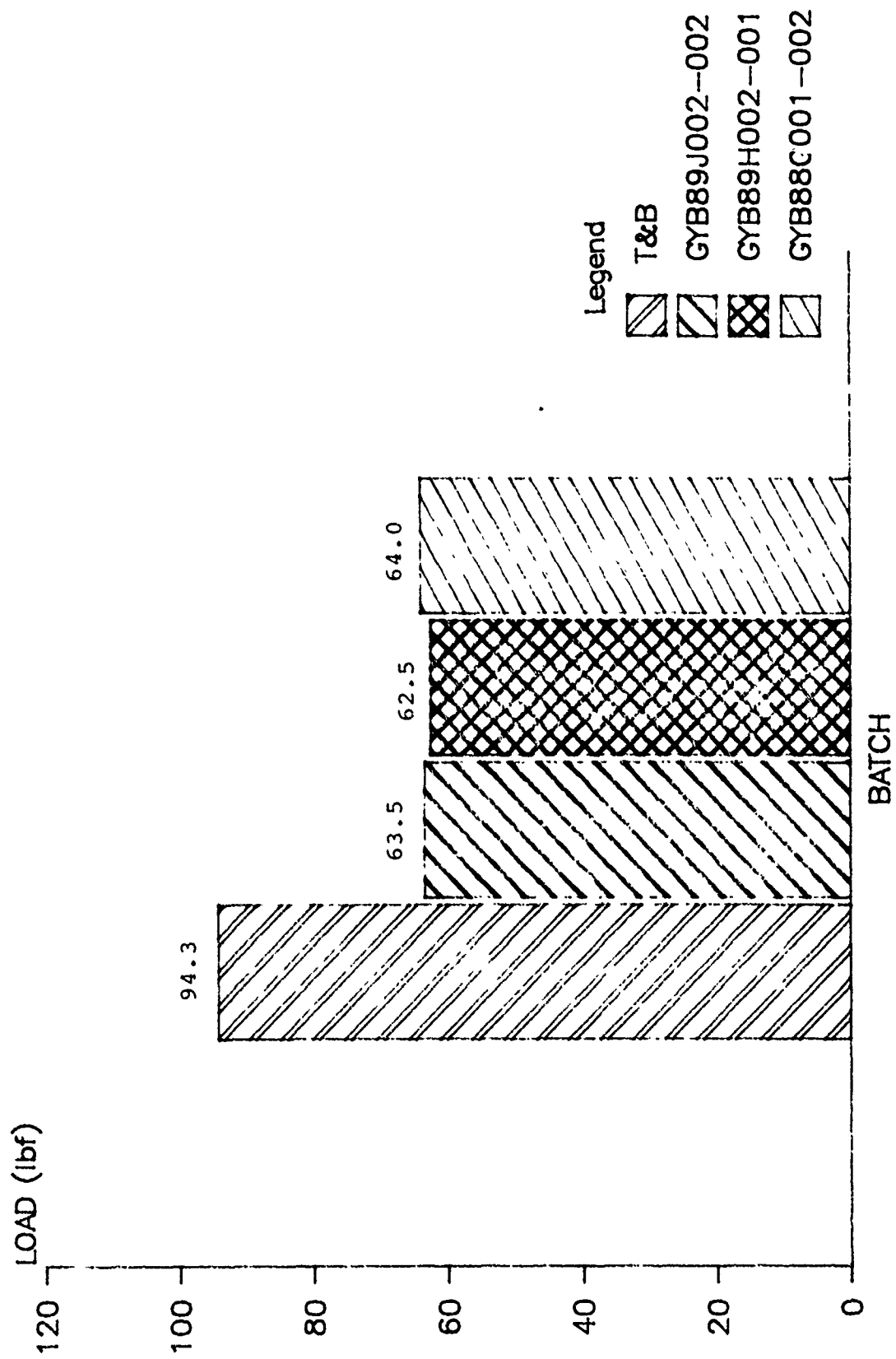


Figure 13. 81 mm M879 plastic handle straps, material strength test (conditioned 2 hr at -50°F)

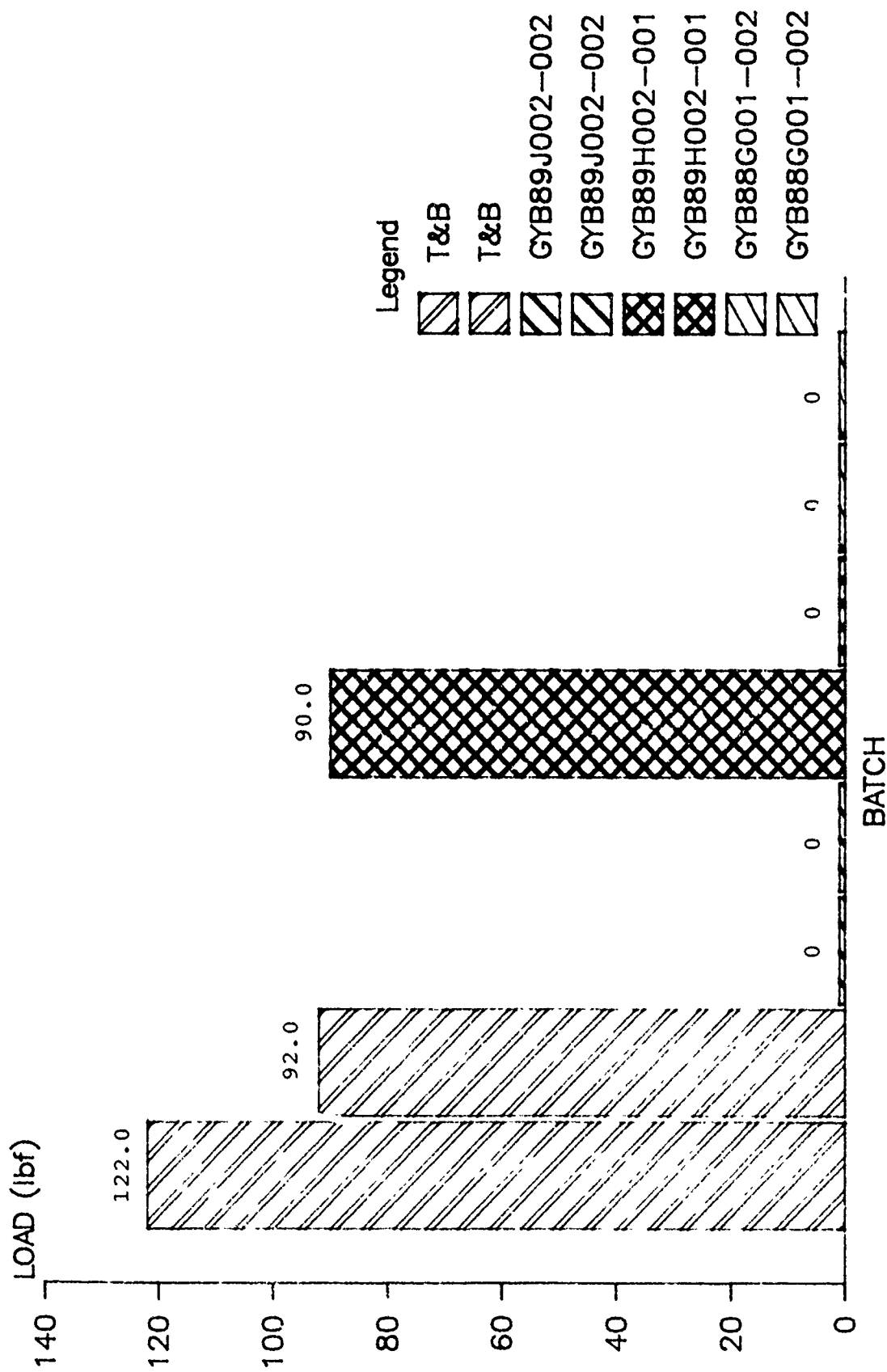


Figure 14. 81 mm M879 plastic handle straps, locking device strength (conditioned 2 hr at -50°F)

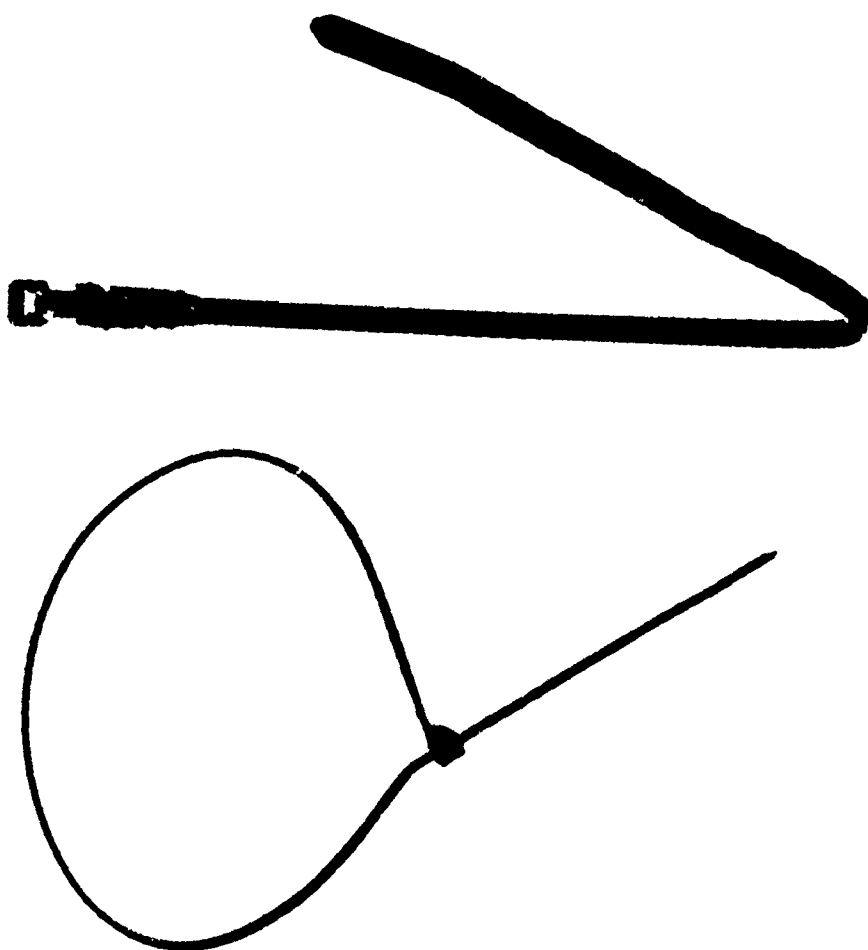


Figure 15. Locking devices of Thomas & Betts (left) and Panduit Corporation (right)

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